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Laboratoire

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Valence (France),
November 27th 2021

To Mr.Bernard DOROSZCZUK
Président de l'ASN
15 rue Louis Lejeune
CS 70013
92 541 Montrouge Cedex

Sent by e-mail

Subject: Request for clarification concerning the cladding rupture incident during cycle 2 of the Taishan 1 EPR and its consequences for the EPR system and the Flamanville EPR site

Mr the President of the ASN (Nuclear Safety Authority),

Context of the request

The French nuclear giants are heavily involved in the Taishan EPR in China: Framatome in the design, construction and fuel supply, EDF in the operation with its 30% stake in TNPJVC. And the feedback from the first years of operation of Taishan 1 and 2 is obviously essential for the Flamanville EPR. The French Nuclear Safety Authority must therefore follow this dossier very closely.

In June 2021, the national and international press widely reported the case of the **nuclear fuel cladding rupture** problems at the **Taishan 1 EPR reactor in China**. This 1,750 MWe reactor is the first EPR to enter commercial operation in the world (in December 2018).

The degradation of the nuclear fuel led its operator, TNPJVC, to an "early" shutdown on 30 July 2021, i.e. about 6 months ahead of the initial cycle time.

The CRIIRAD had alerted on this subject in a press release[1] published on 14 June 2021. The reactor, whose cladding failure problems had in fact been identified as early as **October 2020**, should have been shut down well before July, in order to limit the radiological risks for workers and local residents.

There are several possible causes for these cladding failures. Without being exhaustive, some may be due to design faults in the reactor, others to manufacturing faults, and still others to faults in the operation and/or maintenance of the Taishan 1 reactor.

According to our information, among the various possible causes, some could be generic and also concern the other EPR reactors under construction in Flamanville (France) and Olkiluoto (Finland).

The ASN indicated in a press release[2] dated 16 June 2021 that it was pursuing a "*technical dialogue*" with its counterpart "*the National Nuclear Safety Administration of China (NNSA)*", "*in order to examine to what extent the feedback from the current operating situation in Taishan can be taken into account in the framework of the ongoing examination of the application for the commissioning of the Flamanville EPR*".

According to information sent to CRIIRAD by a whistleblower working in the nuclear industry, the nature of the damage observed on the nuclear fuel assemblies unloaded from the Taishan 1 reactor indicates that it is mainly due to **abnormal vibrations of the nuclear fuel assemblies**.

The damage to the cladding is believed to have started during Cycle 1 and became fully apparent during Cycle 2, particularly on fuel assemblies weakened during the first cycle. According to our informant, the

[1] http://balises.criirad.org/pdf/2021-06-14_INFO_CRIIRAD_Taishan_EPR.pdf
[2] https://www.asn.fr/l-asn-informe/actualites/epr-taishan-l-asn-engage-un-dialogue-technique-avec-son-homologue-chinoise

same problem could very soon affect the Taishan 2 reactor[3], which was put into commercial operation about 9 months after Taishan 1.

According to our informant, these vibrations **would be linked to a design flaw in the EPR reactor vessel**. The EPR vessel is based on the Konvoi (German) model and presents the same problem, namely "*a not very successful hydraulic system at the bottom of the vessel which gives an uneven distribution of power in the assemblies. A transverse current is created in the core and causes the assemblies to move, especially those at the periphery"*.

If confirmed, these revelations raise serious questions in terms of nuclear safety and radiation protection for both plant workers and local residents.

If the existence of a generic design flaw affecting the EPR reactor vessel is confirmed, it is likely to make it impossible to start up the Flamanville and Olkiluoto reactors with a satisfactory level of safety, unless corrective work is undertaken that could prove particularly complex and costly.

Given the issues, CRIIRAD would like to obtain answers to the following questions:

Situation in Taishan

Has ASN been informed (and if so, when) of the detection of an abnormal level of **vibration of the fuel rod assemblies** of the Taishan 1 EPR (from start-up in 2018)?

Has ASN been informed of the detailed results of the diagnosis carried out by the Chinese operator on the Taishan 1 reactor fuel unloaded this summer? Does ASN confirm that there were about 30 leaking assemblies and about **70 leaking rods?** That many of the springs holding the rods in place had broken? That some grids no longer have plates on the neutron reflector side ?

Does ASN have a technical file describing the nature of the degradation observed on the cladding? If so, can we get a copy or, if not, the main data ?

If the Taishan 1 reactor had been operating on French territory with such a degradation of the fuel cladding, would ASN have requested the shutdown of the reactor much earlier and if so, on what date?

Can the ASN communicate to us, if it has the following data :

- the levels of **contamination of the water in the primary circuit** of the Taishan 1 reactor between September 2020 and July 2021 by radioactive rare gases, radioactive iodine, other fission products, uranium and transuranic elements?
- the levels of **radioactive noble gas discharges** to atmosphere from the Taishan 1 reactor between September 2020 (restart in cycle 2) and the end of August 2021?

Consequences for the EPR under construction in Flamanville

Has the ASN been informed of the results of tests on a 0.2 scale model carried out by Framatome at Le Creusot in 2007-2008 to study the hydraulics of the EPR reactor vessel? Is it true that it was necessary to install a deflector under the core plate to try to improve the **distribution of hydraulic flow**, but that its effectiveness was questionable given the lack of space at the bottom of the reactor vessel, which compromises the possibility for the water to make a 180° turn?

If these facts are true, why was the geometry of the EPR tank bottom not questioned at that time? Is it now possible to guarantee the absence of abnormal vibrations affecting the nuclear fuel without a **complete modification of certain elements of the primary circuit** and are these modifications technically possible without reworking the civil engineering and removing the pressure vessel? How soon does the

[3]Cracking of the springs holding the rods and/or wear of the cladding by friction usually takes about 1 cycle. This is why the problem is most often revealed during the second cycle on assemblies that have already undergone one cycle..

ASN believe it will have a complete feedback to enable it to make a decision? Is it not reasonable to consider that this period will be several years?

Does ASN consider it acceptable, in terms of safety and radiation protection, for the new fuel delivered to Flamanville and currently stored[4] in the pool to be loaded into the reactor core as it is, given the feedback from Taishan 1? Doesn't the guarantee of a better resistance of the fuel to vibrations[5]require a **return of the assemblies to the factory** to change the springs holding the rods or even to reinforce the resistance of the grids?

Can the ASN also tell us whether it considers that there is a link between the problems that occurred at Taishan reactor No. 1 and "the problem of high PEL[6] vibrations observed at various EPR reactors" mentioned by the IRSN in its opinion No. 2021-00049 of 31 March 2021, the origin of which has yet to be identified. In any case, CRIIRAD would like to know what the findings are, which reactors are concerned (in particular Flamanville 3) and the state of progress of studies on the causes and solutions.

Regardless of the Taishan 1 feedback, if EDF continues with the construction of the Flamanville EPR and given the new delays announced (EDF is now announcing a start-up date of 2023, which is probably unrealistic), does the ASN not consider that it should require EDF to change the non-compliant reactor vessel head (RVH)before any divergence? **Changing the new RVH** without waiting for it to become radioactive would avoid unnecessary exposure of workers to the radiation that will inevitably be emitted by the activated and contaminated metal parts and would limit the production of radioactive waste.

In addition to the targeted questions listed above, can the ASN provide the CRIIRAD with its analysis of the Taishan 1 feedback and the consequences it draws from it for the future of the Flamanville EPR on the one hand and the design of the EPR2 on the other?

For the CRIIRAD,
Bruno CHAREYRON
Engineer in nuclear physics
Director of the laboratory

Translated from French , December 8th 2021 with www.DeepL.com/Translator (free version)

[4] https://www.edf.fr/la-centrale-nucleaire-de-flamanville-3-epr/les-actualites-de-la-centrale-nucleaire-de-flamanville-3-epr/nouvelle-etape-vers-l-exploitation-du-reacteur-epr-de-flamanville

[5] Some fuel assemblies have to withstand vibrations for 3 cycles, i.e. 3 times 18 months under irradiation.

[6] PEL Pressurizer Expansion Line